Dr McKendrick

with compliments

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(14)

ON

THE STUDY OF ZOOLOGY

AND ITS PLACE IN
MEDICAL AND SCIENTIFIC EDUCATION

BEING

THE INTRODUCTORY LECTURE
DELIVERED TO THE NATURAL HISTORY CLASS,
SCHOOL OF MEDICINE, SURGEONS' HALL,
EDINBURGH
TUESDAY, NOVEMBER 2, 1875.

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ON THE STUDY OF ZOOLOGY

AND

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GENTLEMEN—That the difficulties which beset the writer of an introductory lecture are quite proverbial in their character, is a statement with which, I am certain, every one who has stood in a like position to myself will cordially agree. The selection, preparation, and treatment of his theme form a task, the conclusion of which the lecturer can only view with feelings of the most thankful description. Many conditions combine to invest my present duty with difficulties. The selection of a topic presents the first, and perhaps the most important point for consideration. To choose a theme which shall at once interest beginners in the study, and also prove acceptable to those who may perchance have an intimate acquaintance with the subject-matter of the course, is, at the outset, no light labour. And thus one may be left to hesitate between the Scylla of giving to his mixed audience meat fit for babes alone, on the one hand, and the Charybdis of delivering a highly technical discourse on the other. The latter alternative of the two presents, perhaps, the readiest escape from the difficult environments of the case. And with much ease and satisfaction might one seize such an opportunity as the present occasion offers, to expound some of the many *questiones vexatæ,* which, like persistent litigants, are always on the calling-lists of the biological courts. But to air one's opinions in such a manner would, I am afraid, prove but a sorry welcome to those whose duties I may be privileged to conduct during the ensuing session, and therefore such a mode of occupying the present hour must needs in justice be at once dismissed.

But to choose an equivalent substitute for my technical theme, and to address you on some topic which shall at least interest you as an entire audience, brings me back to my starting-point; and I have therefore thought that the readiest way of cutting the Gordian knot of my difficulty would be to make this introductory discourse a plea or apologia for the study which has been specially assigned to me as my province for cultivation. In the performance of such a task the lecturer may hope to touch on many points of common interest and importance; and it affords him, besides, a favourable opportunity of stating his views regarding the place which he conceives his science most worthy to fill in a curriculum of medical and scientific education.

I must not fail to remark, at the outset, that I have a peculiar satisfaction in occupying the position of Lecturer on Natural History in this famous Medical School. Nor do I think that it lies out of my province to maintain that the exigencies and demands of the education of the medical practitioner of modern times necessitate the presence at least of a teacher of Natural History on the staff of lecturers. I trust to have the pleasure of setting forth in this lecture the arguments whereby the study of Zoology and Comparative Anatomy may be shown to hold a clearly defined place in medical training; and, believing earnestly in the importance of my subject to the student, I shall strive, as best I can, to justify my standing as an extra-academical teacher of what has for the most part been hitherto deemed exclusively an University study.

To open up my theme as widely as possible within the limited time at my disposal, I shall very briefly direct your attention, in the first instance, to the essentials comprised in the modern study of Zoology; then, to the place that the study may reasonably be maintained to hold in a medical curriculum; and lastly, to the use of such studies to the scientific student and to the intelligent world at large. Such ideas as may be comprised within these three topics, I have ventured to hope, may afford a suitable introduction to the labours of the session upon which we have just entered.

The position of zoological science, as one of the subdivisions of the wider science of *Biology* or *Natural History*, is clearly enough defined. Having for its object the investigation of the structural or morphological, the physiological and the distributional aspects of the animal series, it stands out in bold relief beside its neighbour-science of Botany. But the means and methods employed in the investigation of animal forms exactly resemble those of the botanist; and thus to a very great extent, one common track or method marks the pathway of the biological investigator who devotes himself to the study of plants, and of him who, on the other hand, specialises the animal world. If we review the past history of zoological science we shall find that it may claim an honourable place among the studies of antiquity. But the labours of the older naturalists, and indeed of many zoologists who may be deemed of comparatively modern age, consisted in greater part of descriptions of the external form of the organisms which came under their notice; and such descriptive labours culminated, for the most part, in the construction of systems of classification and arrangement. The science, if I may so term it, of *Taxonomy* or *Classification*, may be therefore said to mark distinctly the first epoch of zoological study. Long before the *structural* relations of organisms were investigated as chief objects of natural history study, they were included in artificial systems of arrangement—the characters of these systems being drawn from external resemblances and superficial appearances alone; and it is curious, as well as instructive, to note that frequent traces of such systems are found to be included in the more advanced Zoology of the present day.

In the earliest ages of which we have any reliable historic data, it need scarcely be remarked that Zoology, like its companion branches of natural science, took origin from the metaphysical systems and sciences which constituted the chief studies of the philosophers of antiquity. And it is equally interesting to observe that in these latter days, Zoology especially, has again become intimately commingled, in its hypothetical aspects at least, with the spheres of the theologian and metaphysician. The wider "nature-science" of Physiology thus embraced at first the knowledge of every department of nature in which man's mind could interest itself. But as time passed, and as ideas accumulated and advanced, the older physiology filtered itself out into quite a host of minor sciences, of which Zoology was one of the first to evince a separate and distinct constitution.

It may not be out of place to remark at the present stage of our inquiries that although, in the records of the labours of the ancient philosophers and naturalists much that is absurd and fictional abounds, the student may, nevertheless, very profitably gain a knowledge of their ideas and opinions on many points which still form subjects of earnest inquiry with present-day workers. We may, for example, very reasonably seek to know something of the opinions regarding the nature of life and vital action, or of those respecting the relations of mind and matter, which the earlier thinkers held. Since no one may predict how soon their ideas, decked out in modern guise, may be brought under our notice as existing students of nature-science. And it will form no uninteresting study for some quiet leisure-time, if the student will seek to learn how, in the past for example, Plato and Aristotle, with their characteristic opinions on life and the soul, represented the vitalists, whilst Epicurus and Democritus, believing in matter and force alone, foreshadowed the physicists and materialists of to-day. In such a course of study the student will not only gain the mere information demanded from every intelligent, thinking mind ; but he will also be prepared more fully for the criticism of many modern theories and speculations, which, as set forth by the " advanced " schools of thought, merely reiterate much of the speculative error without any of the excellencies of the views of the past.

It is somewhat difficult to fix any accurate date when Zoology began to be systematically cultivated as an independent study. The descriptive taxonomy which, as we have seen, represented the earlier epochs of the science, persisted down to and inclusive of the time of Linnæus, whose work certainly revolutionised many of the ideas and dogmas of his predecessors. The chief interest, however, which the work of Linnæus will probably possess for the modern student of Zoology will be the enunciation of his ideas regarding the nature of *species*, as well as his comprehensive work in the old paths of taxonomy. Succeeding Linnæus, we find Cuvier standing prominently forward as the pioneer of what we may term the *morphological* epoch of Zoology. With this latter term the name " Comparative Anatomy age " may be deemed synonymous ; since Cuvier, by his investigation of the *structure* of animal forms, laid the foundations of the method whereby, through a knowledge and comparison of the morphology of animals, we are enabled to understand and appreciate their true relationships. The extent and importance of Cuvier's work as marking a new epoch in zoological study cannot be over-estimated. If he has left a name less widely revered than that of Linnæus, it must not be forgotten that his work has been of equal, if not greater value to modern zoologists ; and the epithet of Geoffroy St. Hilaire applied to his great contemporary and friend—"Venez jouer parmi nous le rôle de Linné, d'un autre lêgislateur de l'histoire naturelle"—expresses a just conception of Cuvier's position and excellence.

From the time of Cuvier down to our own day, a long roll of names illustrious in the record of natural history studies might be mentioned. But we may, more profitably for our present purpose, confine our attention to the Zoology of our own day, and note its characteristics as compared with those of the science of the past.

Built up upon the method of Cuvier, and improved by the labours of his successors, the modern study of the animal organism may be said to embrace three, if not four, distinct branches of inquiry. In other words, the modern naturalist directs his examination of living forms in three chief lines of thought. His first duty lies in the province of *Morphology*—the science of Structure; his second in that of *Physiology*—the science of Function; his third in the direction of *Distributional* science, or that of habitat; and, accordingly as we are believers in the doctrine of Evolution or not, we shall add or reject a fourth province, which may be said in a manner to connect the other three—namely, that of the *Ætiology* of living forms. The naturalist of to-day, therefore, cannot be charged with any want of exactness or method in his study. Since his path is clearly marked out and defined; and if he sometimes treads in speculative or other ways in which he should not go, the onus of the mistake cannot be laid on the shoulders of his scientific method. If we examine this method a little more closely, we shall be able to form some idea of the true nature of the zoologist's work, and of its bearings upon other branches of inquiry. His morphological studies lie at the foundation of his science. If he knows not the structure of his organisms, he cannot be said to have advanced one step on his biological journey. But the science of structure has various included aspects, and is altogether of many-sided kind. It of necessity includes *Anatomy,* the means whereby we gain a knowledge of the fully-grown organism; and it no less accounts the study of *Development* one of its essential parts. The knowledge of the full-grown being forms but a part of its history, and without the information derived from its developmental aspect we might in very many instances be puzzled to state either its own relations in the animal series, or those in which it stands to its neighbours. Thus the relationships of many of the lower Crustacean forms, and those of many animals included among the Echinozoa,—or that division of the animal world which, in the words of Edward Forbes, may be called "a refuge for the destitute,"—would be a sealed mystery to us were we not conversant with their developmental history. Since, during their stages of embryonic progress, they evince the homologies and characters which are wholly lost in their adult, and in many cases, degraded condition. As we shall presently observe, the study of development with many, has come to stand forth in our day as the great feature of biological science. Indeed, as modern biologists, we are nothing if we are not embryological. Development and embryology are to the modern zoologist what Morphology was to his predecessors, basing themselves on Cuvier's method. And upon the basis afforded by a study of the embryology of organisms, the newer Ætiology, to be presently noted, is in process of being built up. A third department, formerly, and by some still included in the department of Morphology, is that of *Taxonomy* or *Classification.* It was thus deemed to be the true office of morphology that it furnished details of structure, whereby we might compare organism with organism, or group with group, and so classify them according to their structural likenesses or dissimilarities. But development has in greater part superseded Morphology in this office; and development, not structure, has been invested with the office of showing us the true or genetic mode of relating living beings to one another.

The science of *Physiology* teaches the zoologist the manner in which living beings perform their multifarious functions. Without Physiology the zoologist might well be compared to the palæontologist. For to regard the animal world as a mere collection of structural details, would be to place the student in the position of one, who, visiting a great museum, should fancy that the organisms there displayed were created or formed much as he saw them in the shelves and cases. Morphology, in truth, is but a portion of the zoologist's study. It affords the basis for the acquirement of an equally important investigation—that of knowing how organisms live; how the machinery which Morphology demonstrates, works and labours; and how each part of the actual living organism performs its appropriate and minor function in the greater labour of living and being. Nor can I help regarding this study of Physiological Zoology as a very valuable offset to the teachings of Morphology. For into whatever speculations morphological study may lead, Physiology, if rightly used, will act as an appropriate balance-wheel. Its study is too thoroughly founded on a demonstrative and experimental basis, to passively suffer mere hypothetical considerations to run riot through its domain. And Physiology therefore acts as a check and corrective, as well as a sure test, to most of the deductions of Morphology. Through Physiology, also, we come face to face with all that is bright and living in nature, and the student of zoology can never more truly realise the interest involved in his studies than, when knowing the details of structure, he passes from these details to the investigation of the actual living organism.

Under the Physiological department of zoology the three great processes of *Nutrition*, *Innervation*, and *Reproduction*, with their many included functions, are duly investigated. Through the performance of these three chief actions the organism maintains its existence in, and acts upon the world in which it is placed. They essentially constitute the threefold life of every living being; the first two processes being devoted to the conservation of the individual, and the latter to that of the species or race.

Much as we may know of the history of any organism from a study of Morphology and Physiology alone, there yet remains two important branches of natural history science, without a knowledge of which the biologist would be unable to solve very many knotty points connected with the objects of his studies. Of these two latter branches, that of *Distribution* holds an honourable place in the list of every biologist. Through this department of inquiry, we become familiar with the external conditions of an organism's existence, just as physiology instructed us in those appertaining to its internal life. The habitat, area, or sphere within which the organism at present exists, forms a subject of inquiry for the aspect of *Geographical* Distribution, or, as it is sometimes termed, Distribution in *Space;* whilst the investigation of the area or areas in which it is found within the world as it existed in the past, belongs to *Geological* Distribution, or Distribution in *Time.* Thus zoology becomes related, on the one hand, to Physical Geography, and on the other, and in the most intimate manner, to Geology and Palæontology. The great additions which have been made to our knowledge of Distribution in Space within the past few years have enabled us to solve wholly, or in greater part, many puzzling problems in the history of living organisms; whilst no less has the study of Distribution in Time, or of life in the past, proved a valuable adjunct to our knowledge of life in the present; since light has thereby been thrown on many abstruse points connected with the existing life of our globe.

By the term *Ætiology,* in its etymological sense, we of course mean to indicate that department of knowledge which deals with the *causes* of actions or conditions; and Virgil's line—

> "Felix qui potuit rerum cognoscere causas,"

well expresses his admiration of the sentiment that animates a disciple of Ætiology in any of its aspects. By the expression in its biological sense, we denominate the department of Natural History which seeks to elucidate the development and genealogy of living beings; to trace, according to the doctrine of Descent or Evolution, their genetic resemblances and relationships; and to construct a system of classification, which, being founded on genealogy, will express better and more fully than any other system, the true relationships of living forms. Such is the new sphere of biological research which has been added to the departments of Natural History through the influence and teachings of the evolutionist. Yet it is a department of inquiry which, more reasonably and feasibly perhaps than any other, shows the value of evolutionary views in one aspect at least. We might maintain with Darwin that "the best, and, if our collections were nearly perfect, the only possible arrangement, would be genealogical; descent being the hidden bond of connexion which naturalists have been seeking under the term of the Natural System,"* even though we may not be ardent votaries of Evolution in any of its many aspects. And when he further continues, "On this view we can understand how it is that, in the eyes of most naturalists, the structure of the embryo is even more important for classification than that of the adult,"† we can still sympathise with his opinions. "Thus," to quote Darwin's words again, "community in embryonic structure reveals community of descent;"[*] and so far we may agree with him, although we might come to the point of agreement by diverse routes. And, again, we can only give his statement our assent so far as its result goes, when he says, "Embryology rises greatly in interest, when we look at the embryo as a picture, more or less obscured, of the progenitor, either in its adult or larval state, of all the members of the same great class."[†]

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* *Origin of Species,* 6th ed., p. 395.

† *Ibid.*

Thus, these statements are the expression of an undoubted law in organic life, that the *ontogenesis*, as Hæckel terms it, or development of the individual, repeats in itself the part or whole development (or *phylogenesis*), of the group to which the individual belongs. How far the theory of the evolutionist may fit into and explain these likenesses is quite another matter. The opponent of evolution may be as ready with his ideas of the influence and bearings of fixed "type" as the evolutionist is with his doctrine of descent. The controversial aspects of the law or bearings of Ætiology do not, in my opinion, interfere with its acceptation by the unbiassed student of natural history, as tending to show him relations, at least of logical and feasible kind, between the many and diverse forms that meet his scientific gaze. And through its aid we are now able to relieve ourselves from the embarrassing difficulties of many classifications, by taking Embryology as our guide, and relating those forms whose developments are most nearly akin. In his *Natural History of Creation*[‡] Hæckel has worked out the "Phylogeny" or Ætiology of existing organisms as fully as the knowledge of his day and generation would allow; and we all must admire the aim and work of this Teutonic Darwin, if we cannot agree on the whole with the special position or watch-tower from which he directs his generalised gaze.

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[*] *Origin of Species*, 6th ed., p. 396. [†] *Ibid.*

[‡] *Natürliche Schöpfungs-Geschichte*, von Dr. Ernst Hæckel, Professor an der Universität Jena. Berlin, 1868.

I have thus endeavoured to present to you a very wide and superficial view of the mode in which the zoologist cultivates the fields which he claims as peculiarly his own. But my survey of the requirements for the modern study of Zoology would be most incomplete did I not indicate to you what I consider to be the chief bearings of the Evolution theory on the subject-matter of my course of lectures. I am well aware of the difficulty which attends the clear statement of one's special views on a subject of so wide and varied a nature, and which involves so many considerations of the gravest import. But in these days, when one's works and opinions on all matters relating to natural history science are judged and estimated according to his attitude to this doctrine, it were well that, as professing to instruct others, I should leave none in doubt as to my views on the merits and demerits of Darwinism.

Unquestionably, then, I maintain that the influence of Mr. Darwin's views on Biological science has been in one way of markedly beneficial kind. What Lyell and his predecessors did for Geology in establishing the doctrine of Uniformity, that Mr. Darwin has accomplished for Biology at large. He has shown us without doubt, and in the clearest possible manner, that the various interests, internal and external, of living beings are more universally intercalated, and are more uniform in kind than they were hitherto conceived to be. These points, and the essence of Mr. Darwin's theory, are beautifully and forcibly expressed by Goethe in the lines :—

> " Also bestimmt die Gestalt die Lebensweise des Thieres,
> Und die Weise des Lebens, sie wirkt auf alle Gestalten,
> Mächtig zurück "—

(Hence, each form conditions the life and acts of the creature,
And each fashion of life, with reflex forcible action,
Works on the form :)

Through the researches undertaken both by evolutionists and their opponents upon affinities between the classes of animals, much light, which, but for the stimulus of the Darwinian theory, we would probably have missed altogether, has been thrown on many obscure parts of our science. Best of all, it has to many biologists formed a serviceable working hypothesis, in directing and connecting their studies, and in uniting in a harmony, real or apparent, the diversities so typical of either kingdom of living nature.

Thus, much that is valuable, creditable, and good, I fully and frankly recognise in Darwin's work; and in the effects of that work upon the minds of his contemporaries. But in maintaining that the grandest and most vital question of all —namely, whether the doctrine of universal Evolution is a likely hypothesis, or can be said to be innately true?—must as yet be answered in the negative, I think I assume a position as warrantable and safe as any that can be desired in this controversial age—an age when iconoclasm in opinions scientific, social, and religious, seems to be the order of the day. A modified process of evolution undoubtedly occurs under our eyes. We "breed," and nature "selects," new races, which in time may evince characters of a specific value. But to maintain that this process extends universally and illimitably throughout the wide confines of living nature, is an argument which must be dealt with as one extending even beyond the confines of the domain of lawful hypothesis. In its very extent, the idea of universal Evolution is inapplicable and unworkable. And as we know literally nothing of the innate causes which operate to produce the limited variations of to-day, how much greater and more hopeless of remedy must be our ignorance of the agencies which are alleged to influence beings of the widely diverse kinds we see around us. The energies and possibilities which lie hidden within the developing egg, and the nature of the life and vital powers which direct these energies, are, in their truly essential and actual nature, unknown to the most advanced physiological thought of our day. And much more, it seems to me, must those still grander possibilities and energies, which have similarly made the living creation what it is, remain for ever unknown to us, as great mysteries of inscrutable kind.

Not only, however, in the world of life must the believer in universal Evolution support the existence and power of his principle. The doctrine carries him, *nolens volens*, backwards to the world of non-living matter, and demands, in logical consistency, his assent to the proposition that *Heterogeny* in its widest sense, is not only a possibility, but a probability ; that the lifeless, through some inexplicable process, has and may become elevated into the living, with all its wondrous powers of reacting upon inorganic matter ; that life is one with the physical forces of the universe ; that matter alone is eternal, whilst life is something superadded from time to time to this material basis. The evolution of life from lifeless matter forms, therefore, but a logical sequence to a belief in the evolution of one living form from another.

Through the plain track of the evolutionary doctrine we come face to face with the old problem of *Biogenesis* and *Abiogenesis*. And one is at a loss to conceive how any consistent supporter of the doctrine of Evolution can maintain his beliefs therein, without acquiescing in that of "Spontaneous Generation" also. Yet we find Mr. Darwin's henchman and chief ally, Professor Huxley, exhibiting such inconsistency. Since, after powerfully, and with much fertility of illustration, upholding the doctrine of Biogenesis or that of invariably transmitted life, he yet maintains that were it given him "to look beyond the abyss of geologically recorded time to the still more remote period when the earth was passing through physical and chemical conditions," he "should except to be a witness of the evolution of living protoplasm from not living matter."* I do not interfere with Mr. Huxley's belief as an honest expression of opinion, but I quote his words and practice to strengthen my demand that evolutionists should reasonably extend to others the same privilege of belief, and of exhibiting with themselves an equal amount of "philosophical faith." I plead strongly for toleration on both sides of this great controversy; and if acts of "philosophical faith" lead us to give our assent to other than evolutionary explanations of the origin of this world and its living tenants, we should not be taunted, as with an *argumentum ad invidiam*, that we are much to be pitied on account of our faith.

If the roll of the "drum ecclesiastic" has sometimes been a little deafening, the tones of what we may call the "trombone biological" have on many occasions been of no less of defiant and unreasonable kind. Tyndall himself remarks (*Fortnightly Review*, November 1875), that "in the contemplation of probabilities the thoughtful mind is forced to take a side." And in the "taking of a side," inherent inexplicable belief and innate tendencies of thought count for much with most, if not with all minds. If, therefore, as I have shown, the privilege and reasonable nature of such belief be asserted from the one side, it needs no exercise of apologetics to excuse its adoption by the other. The doctrines of Evolution, Special Creation, and their many modifications, present us at their best with but a choice of probabilities; and in the exercise of this choice the psychical element of belief—too little considered in matters controversial—forms and moulds, in a powerful degree, the after-conceptions of the thinker. Thus, to many, adherence to Evolution, or on the other hand to its opposing theories, may be a necessity as following on the exercise of an innate belief, the nature of which we are neither able to analyse nor comprehend. It is in such a case that all men exemplify the Laureate's words, by

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* *Critiques and Addresses*, p. 239.

> "Believing where we cannot prove."

The study of Zoology, then, in the present age demands from the earnest student and thinker a greater amount of diligence and caution than it has required from him in time past. The labours of specialists in each department of biology are year by year adding largely to our stores of knowledge; and diligence and aptitude are requisite on the part of him who would successfully keep pace with the ever advancing tide. But no less surely must a cautious discernment accompany the footsteps of him who treads in paths biological. He will have continually to be separating theory from fact, implied from obvious truth; he will have ever to be testing and trying the new beliefs as the old ones are displaced and overthrown; his will have to be the constant exercise of apologetics for his beliefs, and of excuses for his opinions; and his will also be the exercise of a cultivated faith, which, with certain hand, will lead the slower reason to heights of knowledge, before deemed of unattainable and unsurmountable kind.

I have thus endeavoured to show what ideas are included in the definite study of Zoology, and it now remains for me to point out the advantages which that study can be shown to confer on the student of medical science, and on the student of more general aims as well. The place of Zoology in a medical curriculum, whilst reasonably admitted and confirmed, has yet formed subject-matter for much disputation and argument. It has seldom, I believe, been attempted to be shown that no need exists for the study; or, in plainer language, that the student would be better without it. The most violent opposition I have been able to discover under this latter head consisted in the element of *time* being urged as an objection The time required for zoological study, it was said, could be ill spared by the student. But as I shall hope to show, whilst the study undoubtedly requires time—and that of no very great amount—its effects and advantages, if properly estimated, more than repay the student in their beneficial influence on his subsequent studies. In the programme of studies necessary to be undertaken for a medical degree, Natural History or Zoology, and its companion-science Botany, have always held a prominent position. And the alleged superiority of the University course over the Extra-Academical programme, has over and over again been argued to consist in the more liberal nature of the former, as furnishing the student with information regarding the living organisms which inhabit the world generally, and as thus opening to him a wider range of studies, and an adequate means of mental training. The advantages of the study of Zoology and Botany have also been not unreasonably argued to consist in giving the junior student a comprehensive view of living organisms, and of furnishing him with useful general ideas on subjects of more strictly professional kind, upon the study of which latter, he has sooner or later to concentrate his whole energies and attention.

Thus the expediency and use of natural science studies have never been absolutely or openly denied, even by those who advocate an education for the medical student which shall be of the most thoroughly practical character—the word "practical" thus used, I take to mean as applying to such studies as are alone deemed to be absolutely necessary to his becoming a duly qualified practitioner, versed in all the science and art of medicine. Such a feeling, expressed or not, I am aware animates the general mind of candidates for a license to practise medicine and surgery. And when one thinks over the nature of the plea put forward on the score of practical studies and time, one can hardly maintain that the student, viewed as striving for excellence in purely medical matters, or his advisers as omitting to insist upon his studying natural science, have committed themselves to a course open to serious reprobation.

The question, however, which clearly presents itself for solution, is not one of rigidly utilitarian nature. It is not one so much of actual expediency, as one of general and abstract kind ; and it very shortly resolves itself into the query "Can Natural History study be shown to be of good service—mark, I do not say of absolute necessity—to the student of medicine ; and, if so, what is its place in the routine and order of medical studies ?"

I presume it will be readily assented to that the more highly cultivated the professional man is, the wider his information, and the more exercised he is in the right use of that information, the more powerful will be his influence and position in his profession and in the world at large. Such a remark applies equally to the clergyman, the lawyer, and the physician, but I think it tells with greatest force in the case of the latter. His sphere is of wider range than the clergyman's, and it is of greater extent than the lawyer's. The peculiar nature of the physician's work brings him into active contact with the busy world at large, and with all its sympathies and sorrows ; and in proportion as his learning, his mental training, and his tastes are respectively great, acute, and polished, so the more truly will he fill his sphere with credit to himself and to his profession. I have advanced these truisms by way of prelude to my proposition that the knowledge of the world, its conditions and affairs, the mental training so valuable to the physician, and the wide sympathy which extends beyond the mere bounds of his professional life, are so many results to be gained from an earnest study of natural science. I do not overstate my case when I say that the training of the intellect in the observation of natural things, the widening of the mental powers, and the stimulation of the observant faculties, are all so many obvious results of such a training in natural science as the busiest among us may readily undergo. These are not abstract or hypothetical results of such studies. They are realities and solid attainments, which may be readily demonstrated by comparing the progress and method of the individual trained in this way, with that of another who has plunged at once into the *medias res* of medical study.

But a still more practical application of natural history to the wants and aims of the student of medicine can be readily found. A prominent complaint, in the opinions of those who speak with authority on medical education, has been the comparative inefficiency of the physiological training, or rather in the results of the study of physiology by the average medical student. Huxley, in his address on *Medical Education,** and speaking as an examiner, complains of the "unreality" of the physiological knowledge of many of the students who came under his notice, and the same complaint has also been heard from other and equally authoritative sources. Now that a knowledge of physiology, or as it is perhaps more graphically termed the "institutes of medicine," is absolutely essential to the wellbeing, success, and to the most vital interests of the medical student, no one can deny; and the chief point for consideration therefore, concerns the improvement of physiological knowledge. That zoological study affords such a means for improving a student's knowledge of physiology, I strongly maintain; and I have long held the opinion that the chief value of natural history to the medical student consisted in the fact that, *when properly taught, the study of Zoology afforded a sure and reasonable basis for the further and more advanced study of pure Physiology.*

Let me illustrate my standing by a single example. The teacher of Zoology has it in his power to survey in a wide, comprehensive manner, the functions of animal life. He treats them after a comparative fashion, and shows how those of different organisms are related to each other. How easy, then, for a teacher with such opportunities, to interweave with his instruction much solid and useful information regarding the broad relations of comparative to human functions. The study of the digestive process and its modifications as observed in the animal series, if properly laid before the student, should so familiarise him with the essential details of the function, that he may enter his Physiology class somewhat prepared to understand the more intricate details which will there be brought under his notice. In the zoology class, the study of reproduction and development cannot but aid his comprehension of the more specialised process of development in man, and through this, affect even his obstetric studies. Whilst even in discussing the curious phenomena of parthenogenesis, the zoological teacher may elucidate much that will widen the conceptions and views of the junior student regarding normal and human development.

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* *Critiques and Addresses*, p. 60.

In short, I regard Zoology, in one sense at least, as a preparatory class for sound physiological training of a comparative kind; and I should have little faith in the use or efficiency of any zoological course of study undertaken by students of medicine which did not make its physiological side a highly prominent feature. As regards the period at which zoology should be taught, I should of necessity make it a study, strictly preliminary in the great majority of cases, to more purely professional branches. I do not consider the question whether or not it should be relegated to the period of ante-professional studies of much importance. I have, however, a great objection to see zoology studied after the fashion of truly "preliminary" subjects; for science of the general preliminary type would not fulfil the high ends I claim for the study. Its study should be so taught and directed that its place as a necessary part of the student's training may ever be kept clearly in view. And if zoology be studied in the student's early career, he will benefit much from its association with the study of Anatomy—to the understanding of which latter branch also, Natural History may in turn be deemed a valuable aid.

But Zoology possesses more direct applications to medical science than as a preparatory study to that of Physiology. I must not neglect to ask you to think of the many ways in which the practice of the physician and the science of the zoologist become intimately correlated. The list of pathological conditions in which, for example, animal organisms and parasites of one kind or another play an important part is by no means of limited extent. And I apprehend it will not be denied that an intelligent knowledge of Medical Zoology—such as may perfectly well and should be given in an ordinary course of zoological studies—will materially assist the physician in his diagnosis and treatment of many a grave case. Thus the cystic form a scolex of a certain species of *Tœnia* (*T. Echinococcus*) inhabiting the dog, is, according to Cobbold, "more frequently the immediate cause of death (in the human subject) than any other internal parasite."* And the same authority states, when speaking of hydatid disease, "You may be well assured, indeed, that I understate the fatal capabilities of Echinococcus disease, when I express the conviction that hydatids prove fatal to 25 per cent of all the human victims they attack. These data," he continues, "ought to have some interest for statisticians and officers of health." And the researches of Davaine in his *Traité des Entozoaires*, of Eschricht, and others, fully confirm Cobbold's estimate of the importance of this single parasitic form in the sphere of the physician. The *Fasciola hepatica*, or liver fluke, more rarely affects man in an injurious fashion, but limits our food-supply by destroying thousands of our sheep annually. A peculiar form of fluke, known as the *Bilharzia hæmatobia*, inhabits various bloodvessels of man, and produces a peculiar and fatal disease in Egypt and other parts of Africa. Even the Common Tapeworm, or *Tænia solium*, is capable, as we all know, of producing very debilitating conditions in the human subject ; whilst its cystic or larval form inhabiting the pig, gives rise in that animal to the "measles" of pork. From underdone beef, man obtains the *T. mediocanellata ;* and the Round Worm (*Ascaris lumbricoides*), and the *Oxyuris* or "Small Thread-worm," are also well known as troublesome guests of the human host. A small Nematoid worm, known as the *Trichina spiralis*, was found to select the human organism as its residence, during part of its developmental cycle. And soon its medical importance became visible, when, on the Continent more particularly, its fatal effects on man began to be practically and frequently demonstrated. In human bloodvessels the peculiar Hæmatozoön, known as *Filaria sanguinis hominis*, sometimes reigns supreme ; and you have but to read the accounts of its development and history, as related by Dr. Lewis, its discoverer, to recognise its pathological significance in the production of "chyluria and elephantoid states of the tissues."

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* *Entozoa*, p. 253.

These few instances out of many, will convince you that Medical Zoology has a very definite and important place in the studies of the physician, and in the interests of public health. And a knowledge of the development and history of these and other parasitic forms, as leading us towards the means for the prevention and cure of the pathological conditions they produce, cannot surely be regarded in any other than the most important light, and as a powerful practical argument for enrolling the study of zoology among the essentials of a liberal professional education. I cannot but imagine that the truly intelligent treatment of parasitic diseases must depend upon a knowledge of what the parasites are, where they came from, and to what development they are proceeding. To-morrow may see a mysterious and fatal lesion of this kind appear, which will require the knowledge of the zoologist for its thorough explanation; and it needs no further argument to show that that knowledge should form a part of the physician's training, and not be left to be acquired by chance—an alternative usually equivalent to its not being acquired at all. I need but mention the results of antiseptic surgery as related to biological research to supplement my arguments in favour of the practical bearings of Zoology in medical education. And if the idea of stamping out contagious diseases—an idea by no means of Utopian kind—ever receives practical confirmation, it should not be forgotten that the labours of biologists in connection with the question of "spontaneous generation" and allied topics, first instigated research into this important subject. Francesco Redi, the naturalist-physician of Florence of some two hundred or more years ago, has left us, in this respect, a rich example of the successful prosecution of biological studies in the interests of medical science, and of humanity at large.

But a few moments remain in which to conclude the task I set myself at the commencement of this discourse. I fear I may already have tried your patience in my endeavours to plead for the extension of my especial branch of inquiry. But I have heard that persistence is a valued quality in a special pleader; and I shall therefore not scruple to detain you, for the short time that remains, in the interests of Zoology as applied to the education of the general student, and of the intellectual world at large.

Not half-a-century ago, as Mr. Darwin tells us, a certain M. Renous was arrested by the wise authorities of the State and Church of St. Fernando, in Chili. It was on account of no heretical or impious conduct that M. Renous fell under the ban of the authorities. But the unfortunate man had kept some caterpillars; the caterpillars, in the course of nature, had become butterflies, and the study or knowledge of insect-metamorphosis forming no part of the Chilian order of affairs, M. Renous was publicly charged with the very serious crime of witchcraft—an offence, by the way, which one would think modern enlightenment might have deleted from the records even of Chilian misdemeanours. I have no fear that any innocent study of natural history objects, such as I advocate for the pursuit of the general student, will subject him to the serious consequences that M. Renous' caterpillars wrought to him. But the incident is at the same time valuable, as showing that, despite the boasted extension of knowledge in these latter days, there are still some persons to whom a course of natural history studies might be of somewhat elevating and rational kind.

The benefits of natural science study to the world at large may be succinctly summed up in the assertion that as a means of mind-training the study is invaluable; and that as a method for effecting a higher education of the observant powers, especially of the young, it is unsurpassed by any other branch of inquiry. That the education of the mind to its due work of thinking is not only a proper but feasible part of common education, is a grand truth slowly but surely beginning to be realised by those whose business it is to act as apostles of "sweetness and light" in matters educational. And as an adjunct to, or as an efficient substitute for the more exact sciences of mathematics and logic, natural science-study may be said to hold its own in the category of educational appliances. As a teacher of some years' experience, and as having had under my care the youth of both sexes, and of almost every age, I can speak with confidence in arguing for the wider recognition of natural science as a means for literally educating the young to think and reason for themselves; and for thus lifting them out of the rut of a purely mechanical to the level of an intelligent routine of school and college studies. The words of Archbishop Whately, when advocating the study of logic, deserve to be remembered as the testimony of one speaking with authority on the subject at present before us.

> "The pursuit of knowledge," says Whately, "on curious and interesting subjects, for its own sake, is usually reckoned no misemployment of time; and is considered as, incidentally, if not directly, useful to the individual, by the exercise thus afforded to the mental faculties. All who study Mathematics are not training themselves to become Surveyors or Mechanics; some knowledge of Anatomy and Chemistry is even expected in a man liberally educated, though without any view to his practising Surgery or Medicine."

And a distinguished writer has very boldly and well summed up all that need be said on this subject, when he maintains that—

> "The habit of seeing; the habit of knowing what we see; the habit of discerning differences and likenesses; the habit of classifying accordingly; the habit of searching for hypotheses which shall connect and explain those classified facts; the habit of verifying these hypotheses by applying them to fresh facts; the habit of throwing them away bravely if they will not fit; the habit of general patience, diligence, accuracy, reverence for facts for their own sake, and love of truth for its own sake; in one word, the habit of reverent and implicit obedience to the laws of Nature, whatever they may be—these are not merely intellectual, but also moral habits, which will stand men in practical good stead in every affair of life, and in every question, even the most awful, which may come before them as rational and social beings."

The influence of biological studies on the minds of even those who are furthest removed from their influence is already assuming a marked and powerful phase. We do not need to be told that biological questions and opinions commingle very largely with the theology and religious ideas of our day; and did time permit, it would form a fit subject of remark that training in things biological, should, for the sake of the opinions they promulgate, form a part of the education of the "Men of Theology," as the Duke of Argyll styles our religious teachers. They would thus be enabled to have something intelligent to say on the "other side" of such great subjects as "Anthropomorphism," the "Automatic Doctrine," the "Evolution Theories," etc., which, like so many bomb-shells, are sent hurling into the camp of theology from the biological stand-point. The Dean of Canterbury, whose orthodoxy no one may question, lays down the strongly expressed opinion on this point, that he is quite sure

> "Theologians must study, intelligently and dispassionately, all those branches of knowledge which are brought into contact with revelation, or they will lose their influence over the intellect of the country. It is no use," says the Dean, "treating physical science as a bugbear. Let our theologians master it, and they will find it a manly study, which will give their minds breadth, will teach them what are the difficulties which press heavily on many thoughtful minds, and which must be fairly met."

And even extending to the province of social economics, and bearing its part in the foundation and formation of a social science and a system of social ethics, do we find biology. You will find in Mr. Herbert Spencer's *Study of Sociology* very much that will interest and impress you on this point. Whether or not you may agree with all he says, he will at least convince you that a strong case is to be made out for the growth and extension of the roots of the biological tree, into all parts of that curiously compounded soil we term "society." And you may learn how "preparation in biology" fits the social economist and lawgiver for his important work. Thus the better a biologist a man is, and the better he understands the laws which regulate life as a whole, the better, it is urged, will he frame just and serviceable laws for the regulation of that higher life exemplified by the human race. Since, to quote Mr. Spencer himself,

> "All social actions being determined by the actions of individuals, and all actions of individuals being vital actions that conform to the laws of life at large, a rational interpretation of social actions implies knowledge of the laws of life."

Or again—

> "Scientific culture in general, then, is needful; and above all, culture of the Science of Life."

and,

> "The Science of Life yields to the Science of Society certain great generalizations, without which there can be no Science of Society at all."

I cannot conclude these remarks without expressing the wish that they may serve at least as an honest advocacy for the wider recognition of the importance of biological science in medical training, in technical and commonplace education, and in all the affairs and matters of ordinary life. I feel very confident that Biology, in itself, will represent the "science of the future;" since, in its wide-spread interests, extending through and uniting the other sciences, the arts, and even social ethics, it will prove itself to be one of the most powerful and humanising studies of the age. Mr. Gladstone, in speaking of the religion and culture of the Greeks, says of that culture, that it "tended powerfully to produce a lofty self-respect, and a large, free, and varied conception of humanity. It incorporated itself in schemes of notable discipline for mind and body, indeed of a lifelong education; and these habits of mind and action had their marked results (to omit many other greatnesses) in a philosophy, literature, and art, which remain to this day unrivalled or unsurpassed." It seems to me that I might search very far before I found a more fitting or appropriate conclusion descriptive of the results of healthy science studies in young and old. And it is not the least marked of these results, that their good effects are cumulative in their character; since they are limited to no day or age, but, with increasing worth, hold good for all time.